

Advanced anatomy of lateral nasal wall

For the endoscopic sinus surgeon

September 19, 2012 · Rhinology

Authors

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Introduction:

Anatomy of the lateral nasal wall is highly complex and variable. With the popularity of endoscopic sinus surgery a thorough knowledge of this complex anatomy is very vital. Highly variable anatomy and paucity of standard landmark makes this region vulnerable for complications during endoscopic sinus surgery. The learning curve for endoscopic sinus surgery is made rather steep by this highly variable anatomy ¹. Study of anatomy of lateral nasal wall dates back to Galen (AD 130-201). He described the porosity of bones in the head. Davinci in his classical anatomical drawings has illustrated maxillary sinus antrum. He also described maxillary sinus as cavities in the bone that supports the cheek ². Highmore (1651) described maxillary sinus anatomy. Hence it is also known as antrum of Highmore ³. It was during the 19th century that Zuckerkandl came out with the first detailed description of maxillary sinus and its surrounding anatomy. Paranasal sinuses are four air filled cavities situated at the entrance of the upper airway. Each of these sinuses are named after the skull bone in which it is located ⁴.

Nasal turbinates:

The turbinates are the most prominent feature of the lateral nasal wall ⁵. They are usually three or sometimes four in number. These turbinates appear as scrolls of bone, delicate, covered by ciliated columnar epithelium. These turbinates sometimes may contain an air cell, in which case it is termed as a concha.

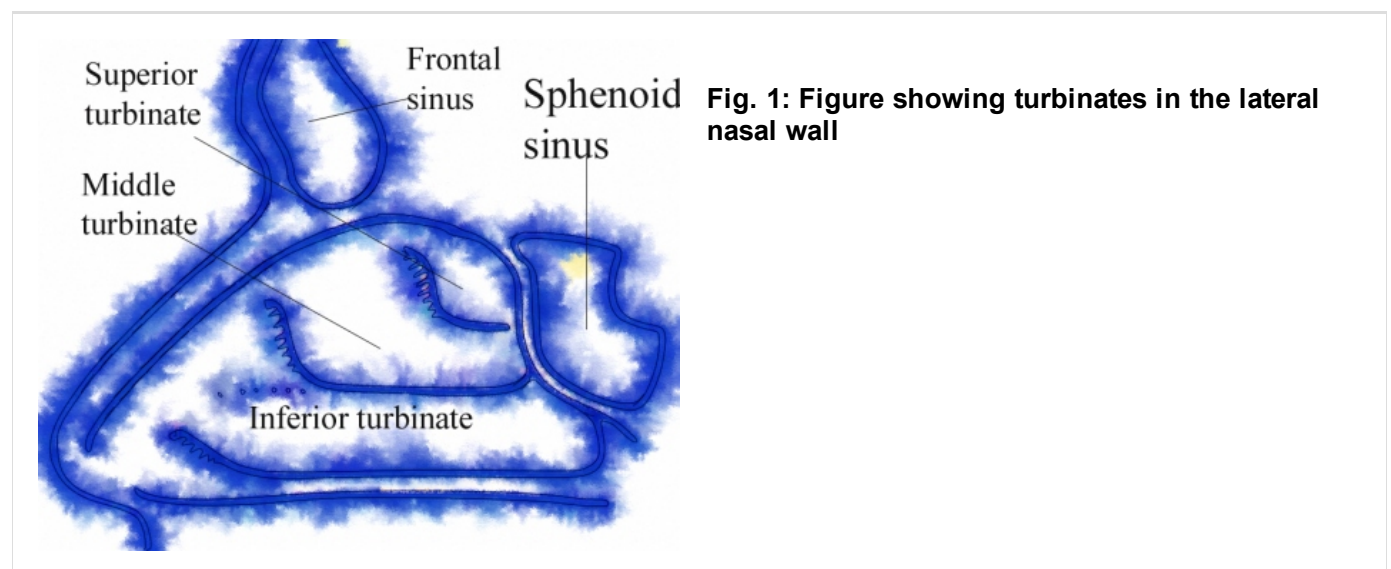
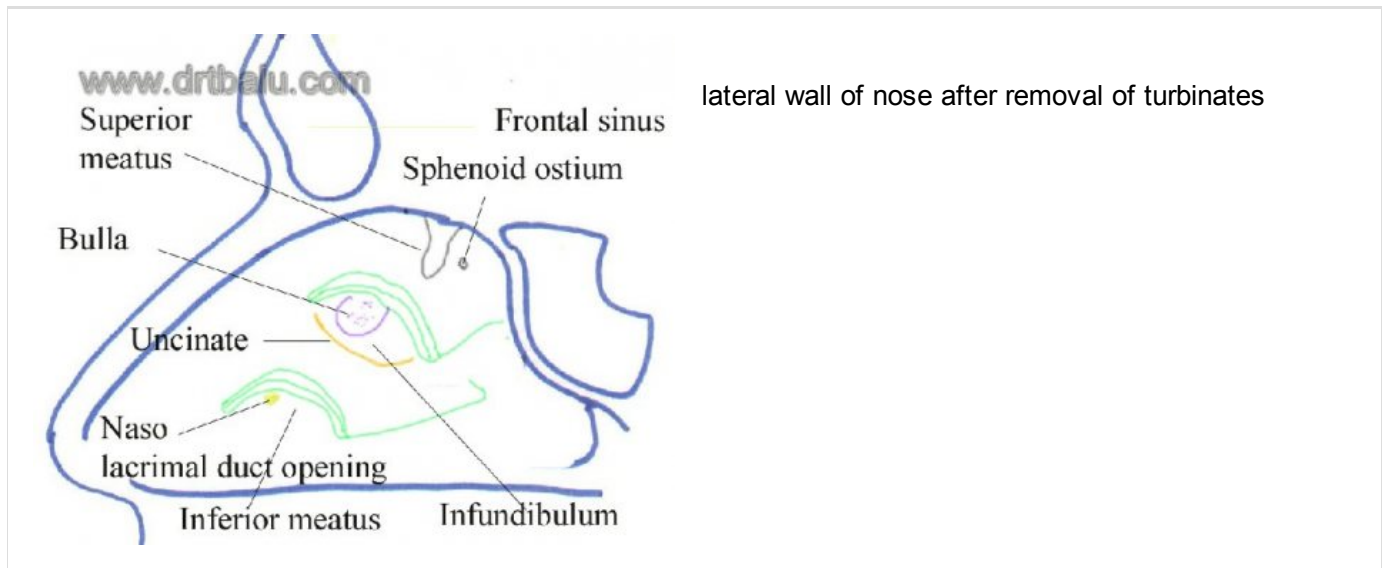


Fig. 1: Figure showing turbinates in the lateral nasal wall

These turbinates project from the lateral wall of the nose. Out of these turbinates the following are present in all individuals:

The superior, middle and inferior turbinates. A small supreme turbinate may be present in some individuals. Among these turbinates the superior and the middle turbinates are components of the ethmoidal complex where as the inferior turbinate is a separate bone. Commonly a prominence may be seen at the attachment of the middle turbinate.



This prominence is known as the agger nasi cell. This prominence varies in size in different individuals. These agger nasi cells overlie the lacrimal sac, separated from it just by a thin layer of bone. Infact this agger nasi cell is considered to be a remnant of naso turbinal bones seen in animals. When the anterior attachment of the inferior and middle turbinates are removed, the lacrimal drainage system and sinus drainage system can be clearly seen.

The inferior turbinate is a separate bone developed embryologically from the maxilloturbinal bone.

The inferior meatus is present between the inferior turbinate and the lateral nasal wall. The nasal opening of the naso lacrimal duct opens in the anterior third of the inferior meatus. This opening is covered by a mucosal valve known as the Hassner's valve. The course of the naso lacrimal duct from the lacrimal sac lie under the agger nasi cell.

The middle meatus lie between the middle turbinate and the lateral nasal wall. The middle turbinate is part of the ethmoidal complex. The sinuses have been divided into the anterior and posterior groups. The anterior group of sinuses are frontal, maxillary and anterior ethmoidal sinuses. These sinuses drain into the middle meatus, i.e. under the middle turbinate. The middle meatus hosts from anterior to posterior the following structures:

1. Agger nasi
2. Uncinate process
3. Hiatus semilunaris
4. Ethmoidal bulla
5. Sinus lateralis
6. Posterior fontanelle

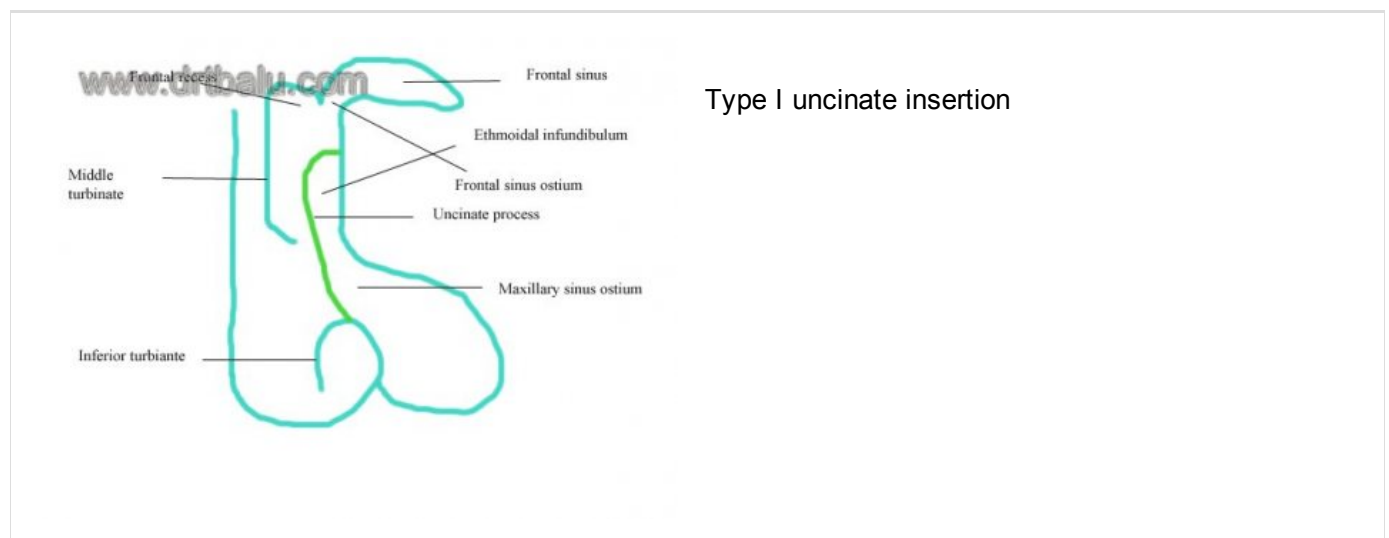
Uncinate process: actually forms the first layer or lamella of the middle meatus. This is the most stable landmark in the lateral nasal wall. It is a wing or boomerang shaped piece of bone. It attaches

anteriorly to the posterior edge of the lacrimal bone, and inferiorly to the superior edge of the inferior turbinate ⁶. Superior attachment of the uncinate process is highly variable, may be attached to the lamina papyracea, or the roof of the ethmoid sinus, or sometimes to the middle turbinate. The configuration of the ethmoidal infundibulum and its relationship to the frontal recess depends largely on the behavior of the uncinate process. The Uncinate process can be classified into 3 types depending on its superior attachment.

The anterior insertion of the uncinate process cannot be identified clearly because it is covered with mucosa which is continuous with that of the lateral nasal wall. Sometimes a small groove is visible over the area where the uncinate attaches itself to the lateral nasal wall. The anterior convex part forms the anterior boundary of the ostiomeatal complex. It is here the maxillary, anterior ethmoidal and frontal sinuses drain. Uncinate process can be displaced medially by the presence of polypoidal tissue, or laterally against the orbit in

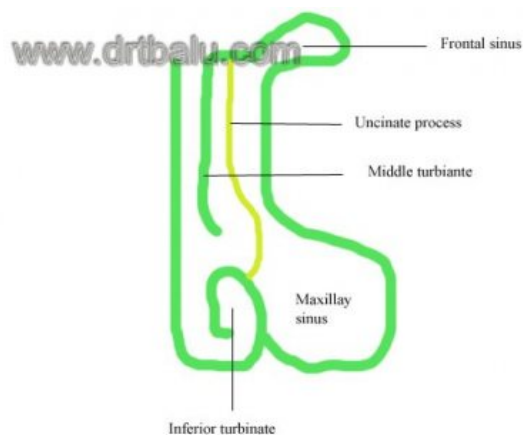
individuals with maxillary sinus hypoplasia ⁷. Removing of this piece of bone is the most important step in Endoscopic sinus surgery.

Type I uncinate: Here the uncinate process bends laterally in its upper most portion and inserts into the lamina papyracea. Here the ethmoidal infundibulum is closed superiorly by a blind pouch called the recessus terminalis (terminal recess). In this case the ethmoidal infundibulum and the frontal recess are separated from each other so that the frontal recess opens into the middle meatus medial to the ethmoidal infundibulum, between the uncinate process and the middle turbinate. The route of drainage and ventilation of the frontal sinus run medial to the ethmoidal infundibulum.



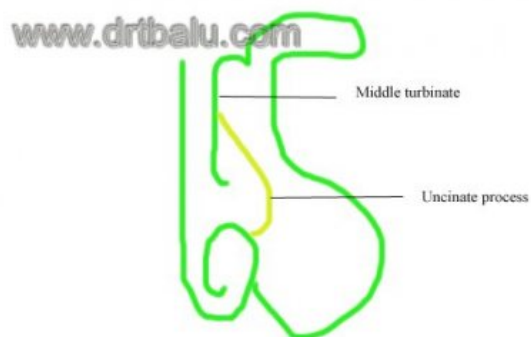
Type II uncinate: Here the uncinate process extends superiorly to the roof of the ethmoid. The frontal sinus opens directly into the ethmoidal infundibulum. In these cases a disease in the frontal recess may spread to involve the ethmoidal infundibulum and the maxillary sinus secondarily. Sometimes the superior end of the uncinate process may get divided into three branches one getting attached to the roof of the ethmoid, one getting attached to the lamina papyracea, and the last getting attached to the middle turbinate.

Type II uncinate insertion

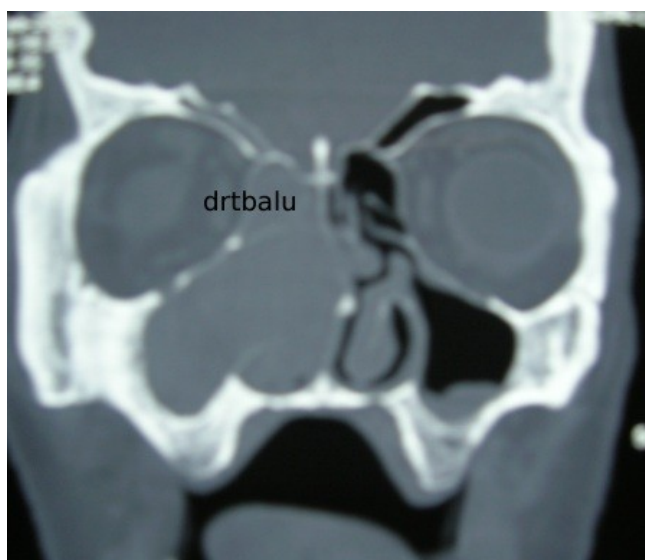


Type III uncinate process: Here the superior end of the uncinate process turns medially to get attached to the middle turbinate. Here also the frontal sinus drains directly into the ethmoidal infundibulum.

Rarely the uncinate process itself may be heavily pneumatized causing obstruction to the infundibulum.



Type III uncinate insertion



Polyp seen pushing the uncinate medially



Hypoplasia of maxillary sinus seen pushing the uncinate laterally

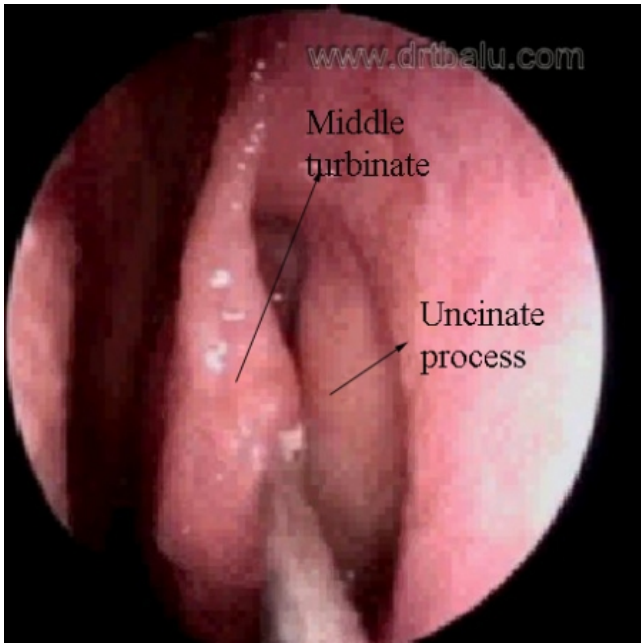


Image showing uncinate process

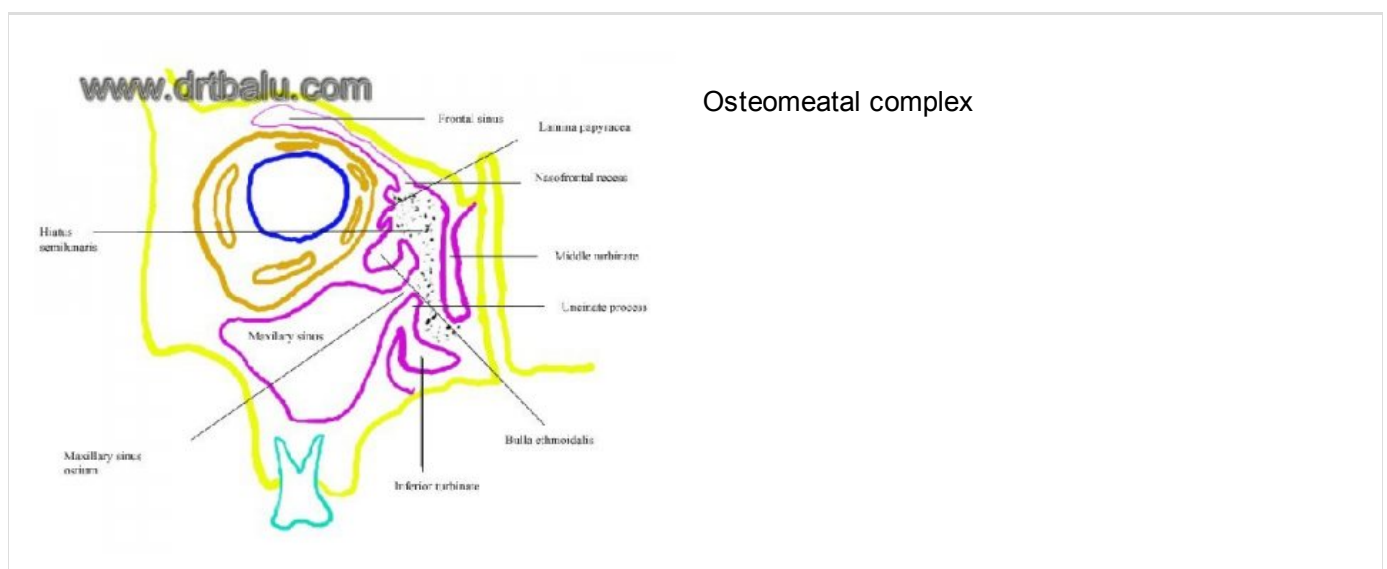
Removal of uncinate process reveals the natural ostium of the maxillary sinus. This is another vital landmark in the lateral nasal cavity. The superior wall of the natural ostium of the maxillary sinus is at the level of floor of the orbit. Agger nasi: This is a latin word for "Mound". This area refers to the most superior remnant of the first ethmoturbinal which presents as a mound anterior and superior to the insertion of middle turbinate. Depending on the pneumatization of this area may reach up to the level of lacrimal fossa thereby causing narrowing of frontal sinus outflow tract. Ethmoidal infundibulum: is a cleft like space, which is three dimensional in the lateral wall of the nose. This structure belongs to the anterior ethmoid. This space is bounded medially by the uncinate process and the mucosa covering it. Major portion of its lateral wall is bounded by the lamina papyracea, and the frontal process of maxilla to a lesser extent. Defects in the medial wall of the infundibulum is covered with dense connective tissue and periosteum. These defects are known as anterior and posterior fontanelles. Anteriorly the ethmoidal infundibulum ends blindly in an acute angle.



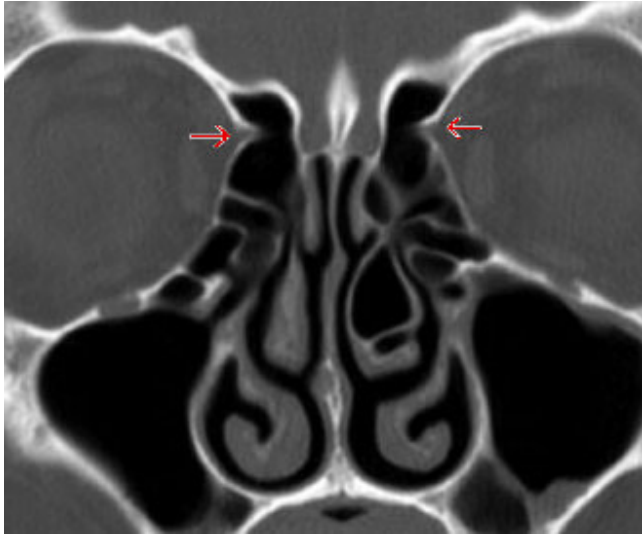
Figure showing large agger nasi air cell

Bulla ethmoidalis: This is derived from Latin. Bulla means a hollow thin walled bony prominence. This is another landmark since it is the largest and non variant of the aircells belonging to the anterior

ethmoidal complex. This air cell is formed by pneumatization of bulla lamella (second ethmoid basal lamella). This air cell appears like a bleb situated in the lamina papyracea. Some authors consider this to be a middle ethmoid cell. If bulla extends up to the roof of ethmoid it can form the posterior wall of frontal recess. If it does not reach up to the level of skull base then a recess can be formed between the bulla and skull base. This recess is known as suprabullar recess. If the posterior wall of bulla is not in contact with basal lamella then a recess is formed between bulla and basal lamella. This recess is known as retrobullar recess / sinus lateralis. This retrobullar recess may communicate with the suprabullar recess. Osteomeatal complex: This term is used by the surgeon to indicate the area bounded by the middle turbinate medially, the lamina papyracea laterally, and the basal lamella superiorly and posteriorly. The inferior and anterior borders of the osteomeatal complex are open. The contents of this space are the agger nasi, nasofrontal recess (frontal recess), infundibulum, bulla ethmoidalis and the anterior group of ethmoidal air cells. This is in fact a narrow anatomical region consisting of : 1. Multiple bony structures (Middle turbinate, uncinate process, Bulla ethmoidalis) 2. Air spaces (Frontal recess, ethmoidal infundibulum, middle meatus) 3. Ostia of anterior ethmoidal, maxillary and frontal sinuses. In this area, the mucosal surfaces are very close, sometimes even in contact causing secretions to accumulate. The cilia by their sweeping movements pushes the nasal secretions. If the mucosa lining this area becomes inflamed and swollen the mucociliary clearance is inhibited, eventually blocking the sinuses. Some authors divide this osteomeatal complex into anterior and posterior. The classic osteomeatal complex described already has been described as the anterior osteomeatal complex, while the space behind the basal lamella containing the posterior ethmoidal cells is referred to as the posterior ethmoidal complex, thus recognising the importance of basal lamella as an anatomical landmark to the posterior ethmoidal system. Hence the anterior and the posterior osteomeatal complex has separate drainage systems. So when the disease is limited to the anterior compartment of the osteomeatal complex, the ethmoid cells can be opened and diseased tissue removed as far as the basal lamella, leaving the basal lamella undisturbed minimising the risk during surgery. Hiatus semilunaris: Lies between the anterior wall of the Bulla and the free posterior margin of the uncinate process. This is in fact a two dimensional space. Through this hiatus a cleft like space can be entered. This is known as the ethmoidal infundibulum. This ethmoidal infundibulum is bounded medially along its entire length by the uncinate process and its lining mucosa. The lateral wall is formed by the lamina papyracea of the orbit, with participation from the frontal process of the maxilla and the lacrimal bone. The anterior group of sinuses drain into this area. In fact this area acts as a cess pool for all the secretions from the anterior group of sinuses.



Concha bullosa: Sometimes middle turbinate may become pneumatized. This pneumatization is known as concha bullosa. This process of pneumatization starts either from frontal recess or agger nasi air cells. This is usually considered to be a normal variant. Sometimes this pneumatization may become so extensive that it could cause obstruction in osteomeatal complex ⁸.



Coronal CT showing concha bullosa

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